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tion is not of importance, but any variation from a constant value in a given series of observations will affect the results. The observer should know the circumstances which cause it to vary, and where these variations have been carefully determined corrections may be applied. When possible it is better to make the conditions of observation such that these variations will be eliminated.

THE DEFINITION OF THE TERM DOUBLE STAR.

By R. G. Aitken,

The limits of distance and magnitude within which a pair of stars must come to be entitled to the classification of *double star* have been left, up to this time, entirely to the discretion of the individual observer. Thus Struve's distance limit is 32″, Espin's 10″, my own 5″. The result is that hardly any two catalogues of double-star discoveries are comparable with each other, and that a complete catalogue, like Burnham's "General Catalogue," contains a most heterogeneous collection of objects. The question arises whether it is not desirable to change this condition so far as future work is concerned.

Any definition of a double star must, in the nature of the case, be more or less arbitrary, for it is obviously impossible to discriminate by any descriptive terms between a pair of stars which constitute a physical system (binary stars) and a pair that is merely associated optically. The choice rests between as many arbitrary definitions as there are observers, and a single working definition adopted by general agreement.

In framing a working definition certain principles must be observed: (1) While it is not essential nor, indeed, possible to set limits of distance and magnitude that will include all possible physical systems, they should be so drawn as to include substantially all pairs likely to prove of interest as binaries, while excluding most of the merely optical pairs; (2) The limits should be simple enough to be easily remembered and applied by the observer at the telescope; (3) Provision should be made for exceptional pairs of stars beyond the adopted limits.

Certain practical points, to be noted later, should also be taken into account.

It has long been my conviction that the adoption of such a definition is desirable. Accordingly, in July 1910, I addressed a letter to a number of astronomers who were likely to be interested, advocating the plan, and submitting a tentative set of limits as a basis for discussion. The responses made it evident that the great majority were in favor of the proposition. The provisional definition was therefore modified, after a careful study of the helpful suggestions offered, and then submitted to the same correspondents for further criticism. The statement which follows is the result of this entire discussion, but I alone am responsible for its form. How far it meets the approval of my correspondents will appear from the quotations from their letters which are appended.[1]

I. *Definition:* (1) Two stars shall be considered to constitute a double star when the apparent distance between them falls within the following limits:—

1″	if the combined magnitude of the components is fainter than 11.0
3″	“ “ “ “ “ “ “ “ 9.0 B.D.
5″	“ “ “ “ “ lies between 6.0 and 9.0 B.D.
10″	“ “ “ “ “ “ “ 4.0 and 6.0 B.D.
20″	“ “ “ “ “ “ “ 2.0 and 4.0 B.D.
40″	“ “ “ “ “ is brighter than 2.0 B.D.

(2) Pairs which exceed these limits shall be entitled to the name double star only when it has been shown (a) that orbital motion exists; (b) that the two components have a well-

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NOTES.—The limits set in I (1) apply only to future discoveries, not to pairs already published as “double stars.” Ternary and close multiple systems are included in the word “pair.” The B. D. is taken as standard for magnitude because no photometric catalogue extends to the 9.0 stars. For stars south of —23° declination, it will be necessary to substitute the Cordoba D. M. or the Cape Photographic D. M.

The wide pair, Groombridge 34, may be taken as an example of the cases provided for in paragraph (2) of the definition. It is not included in any double-star catalogue, being too wide even for STRUVE’S limits, but the two components have the same large proper motion and the same parallax and, doubtless, constitute a true binary system, as SCHLESINGER has pointed out.[2]

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[1] These quotations are omitted here. The reader who is interested is referred to the original article in *Astronomische Nachrichten*, 4505, **188**, 281, 1911.

[2] *Astrophysical Journal*, **33**, 173, 1911.

defined common proper motion or proper motions of the 61 *Cygni* type; (c) that the parallax is decidedly greater than the average for stars of corresponding magnitude.

II. It is respectfully requested that astronomers observe the limits given in the definition (1) in publishing lists of new double stars. It is also *strongly urged* that the announcement of every new double star gives its accurate identification and a correct description (measures, if possible), including the position-angle, distance and relative magnitudes, and also the combined magnitude from some standard photometry or from one of the "Durchmusterungen."

In the letters of Professors Pickering and Comstock, formulæ are suggested which give more rigorous relations between the magnitudes and angular separation of two stars, under assumptions stated in the letters, than the broken line adopted in definition (I). Taking the constants in these formulæ such that they shall give a limiting distance of 5″ for a pair of stars whose combined magnitude is 6.0, I have computed values for comparison as follows:—

Magnitude	Adopted limits.	Pickering's limits.	Comstock's limits.
1	40″	50″	116″
2		32	61
3	20	20	33
4		12.5	17.5
5	10	8	9+
6		5	5
7	5	3	3
8		2	1.5
9		1.25	0.75
10	3	0.8	0.5

The adopted limits are wider than those given by the formulæ for stars fainter than 4.5 and 5.0 magnitude, respectively, but narrower for the brighter stars, though the difference is not very great in the latter case till we reach the second magnitude.

I prefer the broken line, or series of steps, to the more rigorous curves, not only because it is simpler and therefore better adapted to practical use at the telescope, but also from the following considerations:—

The limit 5″ appears to be amply large for a pair of stars whose combined magnitude is 6.0, for on the reasonable assumptions that the parallax of such a pair is 0″.01, its mass double the Sun's mass, and the mean distance (in the true orbit) between the components not less than their apparent separation, the revolution period is not less than 7,900 years.[1] Pairs with longer periods than this may safely be neglected in a "working definition."[2] But the limits for the fainter stars should be wider than those corresponding to 5″ for sixth magnitude stars according to the rigorous formulæ, because evidence is accumulating from all sides to show that stars of different magnitudes are more thoroughly mixed in space than has been assumed in the past. Experience has shown, also, that easy pairs under 5″ are likely to escape detection by meridian observers, and pairs under 3″ by those who examine the *carte du ciel* plates. It is clearly desirable to list all such pairs as double stars, not only for the practical reason that it is important to know what stars in our standard catalogues have close companions, but particularly because knowledge of the relative motions in such pairs can only be gained by micrometric measures.

The stars brighter than 4½ magnitude are not only few in number, but they have all been repeatedly examined with large telescopes for companion stars. The limits to be assigned for them are, therefore, of less importance practically. Those adopted, it will be seen, meet the approval of the majority of double-star observers.

It remains to be said, with all possible emphasis, that there is not the slightest reason why the adoption of this definition should discourage the use of the micrometer in the measurement of wider pairs of stars. Every careful micrometric measure is now or will be hereafter of value. But it is misleading and really of detriment both to the observer and to the progress of astronomy to publish all micrometric measures of pairs of stars as "double-star measures." Far better is it to publish them under a title which correctly describes the observer's purpose in making them—e. g. "measures for the proper motions of faint stars."

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[1] If the parallax is taken 0″.02 and the mass eight times the solar mass, improbably large values in the light of our present knowledge, the period will still be 1,400 years.

[2] Micrometer measures will not establish motion in pairs with this period in less than a century, unless the companion is approaching periastron. But in that event the apparent separation will be much less than 5″.

Finally, I would repeat that it is not essential to have a definition of a double star which shall include every possible physical system. Very little harm will be done if an occasional binary is overlooked for a century or two; such oversight, indeed, is bound to occur in any event. But it does seem desirable, in the interest of clearness and precision, to substitute for the many arbitrary ones now in use, a single definition that is practical even if not ideal.

PLANETARY PHENOMENA FOR JULY AND AUGUST, 1911.

By Malcolm McNeill.

PHASES OF THE MOON, PACIFIC TIME.

First Quarter..	July 3,	$1^h 20^m$ A.M.	First Quarter..	Aug. 1,	$3^h 29^m$ P.M.
Full Moon	" 11,	4 53 A.M.	Full Moon	" 9,	6 55 P.M.
Last Quarter ..	" 18,	9 31 P.M.	Last Quarter ..	" 17,	4 11 A.M.
New Moon ...	" 25,	12 12 P.M.	New Moon	" 23,	8 14 P.M.
			First Quarter ..	" 31,	8 21 A.M.

The Earth reaches its greatest distance from the Sun on July 2d, 11 P. M., Pacific time.

Mercury passes superior conjunction with the Sun on July 3d and becomes an evening star. It reaches its greatest east elongation on August 13th, and by the end of that month has nearly reached inferior conjunction. From the middle of July to the middle of August it does not set until an hour or more after the Sun, so that it may be seen in the evening twilight under favorable weather conditions. Eastern elongations of *Mercury* after the middle of the year do not generally give a good opportunity for observations, but the present greatest east elongation, 27° 26′, is an unusually large one, as it occurs on the same night as perihelion for the planet; so there is a fair chance of seeing the planet as an evening star for a few days before and after August 1st.

Venus remains an evening star, setting rather more than two and one-half hours after sunset on July 1st, but the interval